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# 1 [The RADIANCE lighting simulation and rendering system](#)

Gregory J. Ward

 July 1994 **Proceedings of the 21st annual conference on Computer graphics and interactive techniques**

Full text available: pdf(2.36 MB)

 Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

This paper describes a physically-based rendering system tailored to the demands of lighting design and architecture. The simulation uses a light-backwards ray-tracing method with extensions to efficiently solve the rendering equation under most conditions. This includes specular, diffuse and directional-diffuse reflection and transmission in any combination to any level in any environment, including complicated, curved geometries. The simulation blends deterministic and stochastic ray-trac ...

**Keywords:** Monte Carlo, lighting simulation, physically-based rendering, radiosity, ray-tracing

## 2 [A lighting reproduction approach to live-action compositing](#)

Paul Debevec, Andreas Wenger, Chris Tchou, Andrew Gardner, Jamie Waese, Tim Hawkins

 July 2002 **ACM Transactions on Graphics (TOG) , Proceedings of the 29th annual conference on Computer graphics and interactive techniques**, Volume 21 Issue 3

Full text available: pdf(25.36 MB)


 Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We describe a process for compositing a live performance of an actor into a virtual set wherein the actor is consistently illuminated by the virtual environment. The Light Stage used in this work is a two-meter sphere of inward-pointing RGB light emitting diodes focused on the actor, where each light can be set to an arbitrary color and intensity to replicate a real-world or virtual lighting environment. We implement a digital two-camera infrared matting system to composite the actor into the ba ...

**Keywords:** global illumination, image-based lighting, matting and compositing, radiosity, reflectance and shading

## 3 [Light fields and matting: Capturing and rendering with incident light fields](#)

J. Unger, A. Wenger, T. Hawkins, A. Gardner, P. Debevec

June 2003 **Proceedings of the 14th Eurographics workshop on Rendering**Full text available:  [pdf\(6.30 MB\)](#)Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

This paper presents a process for capturing spatially and directionally varying illumination from a real-world scene and using this lighting to illuminate computer-generated objects. We use two devices for capturing such illumination. In the first we photograph an array of mirrored spheres in high dynamic range to capture the spatially varying illumination. In the second, we obtain higher resolution data by capturing images with an high dynamic range omnidirectional camera as it traverses across ...

4 Acquiring the reflectance field of a human face

Paul Debevec, Tim Hawkins, Chris Tchou, Haarm-Pieter Duiker, Westley Sarokin, Mark Sagar  
July 2000 **Proceedings of the 27th annual conference on Computer graphics and interactive techniques**

Full text available:  [pdf\(3.70 MB\)](#)Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We present a method to acquire the reflectance field of a human face and use these measurements to render the face under arbitrary changes in lighting and viewpoint. We first acquire images of the face from a small set of viewpoints under a dense sampling of incident illumination directions using a light stage. We then construct a reflectance function image for each observed image pixel from its values over the space of illumination directions. From the reflectance functions, we can directl ...

**Keywords:** facial animation, image-based modeling, rendering and lighting

5 Light scattering from human hair fibers

Stephen R. Marschner, Henrik Wann Jensen, Mike Cammarano, Steve Worley, Pat Hanrahan  
July 2003 **ACM Transactions on Graphics (TOG)**, Volume 22 Issue 3

Full text available:  [pdf\(15.64 MB\)](#)Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Light scattering from hair is normally simulated in computer graphics using Kajiya and Kay's classic phenomenological model. We have made new measurements of scattering from individual hair fibers that exhibit visually significant effects not predicted by Kajiya and Kay's model. Our measurements go beyond previous hair measurements by examining out-of-plane scattering, and together with this previous work they show a multiple specular highlight and variation in scattering with rotation about the ...

**Keywords:** fibers, hair, optical scattering, rendering

6 The lumigraph

Steven J. Gortler, Radek Grzeszczuk, Richard Szeliski, Michael F. Cohen  
August 1996 **Proceedings of the 23rd annual conference on Computer graphics and interactive techniques**

Full text available:  [pdf\(334.72 KB\)](#)Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)7 Appearance modelling and rendering: The free-form light stage

Vincent Masselus, Philip Dutré, Frederik Anrys  
July 2002 **Proceedings of the 13th Eurographics workshop on Rendering**

Full text available:  [pdf\(8.96 MB\)](#)Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

terms

We present the Free-form Light Stage, a system that captures the reflectance field of an object using a free-moving, hand-held light source. By photographing the object under different illumination conditions, we are able to render the object under any lighting condition, using a linear combination of basis images. During the data acquisition, the light source is moved freely around the object and hence, for each picture, the illuminant direction is unknown. This direction is estimated automatic ...

8 Lighting & sampling: An approximate global illumination system for computer generated films

Eric Tabellion, Arnauld Lamorlette

August 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 3

Full text available:  pdf(819.51 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Lighting models used in the production of computer generated feature animation have to be flexible, easy to control, and efficient to compute. Global illumination techniques do not lend themselves easily to flexibility, ease of use, or speed, and have remained out of reach thus far for the vast majority of images generated in this context. This paper describes the implementation and integration of indirect illumination within a feature animation production renderer. For efficiency reasons, we ch ...

**Keywords:** distributed ray tracing, global illumination, irradiance caching, micro-polygon, rendering

9 Inverse global illumination: recovering reflectance models of real scenes from photographs

Yizhou Yu, Paul Debevec, Jitendra Malik, Tim Hawkins

July 1999 **Proceedings of the 26th annual conference on Computer graphics and interactive techniques**

Full text available:  pdf(475.61 KB) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

**Keywords:** BRDF models, albedo maps, global illumination, image-based modeling and rendering, radiance, radiosity, reflectance recovery, rendering

10 Linear light source reflectometry

Andrew Gardner, Chris Tchou, Tim Hawkins, Paul Debevec

July 2003 **ACM Transactions on Graphics (TOG)**, Volume 22 Issue 3

Full text available:  pdf(12.74 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#)

This paper presents a technique for estimating the spatially-varying reflectance properties of a surface based on its appearance during a single pass of a linear light source. By using a linear light rather than a point light source as the illuminant, we are able to reliably observe and estimate the diffuse color, specular color, and specular roughness of each point of the surface. The reflectometry apparatus we use is simple and inexpensive to build, requiring a single direction of motion for t ...

11 Flash & color: Non-photorealistic camera: depth edge detection and stylized rendering using multi-flash imaging

Ramesh Raskar, Kar-Han Tan, Rogerio Feris, Jingyi Yu, Matthew Turk

August 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 3

Full text available:  pdf(756.83 KB)

 [mov\(25:40 MIN\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

We present a non-photorealistic rendering approach to capture and convey shape features of real-world scenes. We use a camera with multiple flashes that are strategically positioned to cast shadows along depth discontinuities in the scene. The projective-geometric relationship of the camera-flash setup is then exploited to detect depth discontinuities and distinguish them from intensity edges due to material discontinuities. We introduce depiction methods that utilize the detected edge features t ...

**Keywords:** depth edges, image enhancement, non-photorealistic rendering

## 12 [A fast relighting engine for interactive cinematic lighting design](#)

Reid Gershbein, Pat Hanrahan

July 2000 **Proceedings of the 27th annual conference on Computer graphics and interactive techniques**

Full text available:  [pdf\(596.95 KB\)](#) Additional Information: [full citation](#), [abstract](#), [citations](#), [index terms](#)

We present new techniques for interactive cinematic lighting design of complex scenes that use procedural shaders. Deep-framebuffers are used to store the geometric and optical information of the visible surfaces of an image. The geometric information is represented as collections of oriented points, and the optical information is represented as bi-directional reflection distribution functions, or BRDFs. The BRDFs are generated by procedurally defined surface texturing functions that spatia ...

**Keywords:** animation, illumination, image-based rendering, optics, rendering, rendering hardware, texture mapping

## 13 [Capturing the real world: A local model of eye adaptation for high dynamic range images](#)

Patrick Ledda, Luis Paulo Santos, Alan Chalmers

November 2004 **Proceedings of the 3rd international conference on Computer graphics, virtual reality, visualisation and interaction in Africa**

Full text available:  [pdf\(700.84 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In the real world, the human eye is confronted with a wide range of luminances from bright sunshine to low night light. Our eyes cope with this vast range of intensities by adaptation; changing their sensitivity to be responsive at different illumination levels. This adaptation is highly localized, allowing us to see both dark and bright regions of a high dynamic range environment. In this paper we present a new model of eye adaptation based on physiological data. The model, which can be easi ...

**Keywords:** eye adaptation, high dynamic range, human visual system, tone mapping

## 14 [A final reconstruction approach for a unified global illumination algorithm](#)

Xavier Granier, George Drettakis

April 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 2

Full text available:  [pdf\(4.41 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In the past twenty years, many algorithms have been proposed to compute global illumination in synthetic scenes. Typically, such approaches can deal with specific lighting configurations, but often have difficulties with others. In this article, we present a final reconstruction step for a novel *unified approach* to global illumination that automatically detects different types of light transfer and uses the appropriate method in a closely-integrated manner. With our approach, we can deal ...

**Keywords:** Global illumination, density estimation, final gather, hierarchical radiosity with clustering, particle tracing

15 Invited paper: Visual attention models for producing high fidelity graphics efficiently

Alan Chalmers, Kirsten Cater, David Maffioli

April 2003 **Proceedings of the 19th spring conference on Computer graphics**

Full text available:  pdf(672.92 KB) Additional Information: [full citation](#), [abstract](#), [references](#)


Despite the ready availability of modern high performance graphics cards, the complexity of the scenes being modelled and the realism required of the images means that rendering high fidelity computer images is still simply not possible in a reasonable, let alone real-time. Knowing that it is a human that will be looking at the resultant images can be exploited to significantly reduce the computation time required for high fidelity graphical images, for although the human visual system is good, ...

**Keywords:** realistic computer graphics, saliency maps, task maps, visual perception

16 Rendering: Multiple light field rendering

Jarno van der Linden

February 2003 **Proceedings of the 1st international conference on Computer graphics and interactive techniques in Australasia and South East Asia**

Full text available:  pdf(10.62 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)


A light field is a 4D function describing the radiance across a boundary between the volume containing a scene, and the disjoint volume in which the eyepoint may be placed. Light field rendering is the process of rendering novel views of a scene captured by the light field function. It is a purely image-based rendering technique which uses no geometric knowledge of the scene. Although the lack of needed geometric information make light fields an attractive way of capturing real-world scenes, it ...

**Keywords:** composition, intersection, light field rendering, terrain visualization

17 Refinement, visibility and selective rendering: Detail to attention: exploiting visual tasks for selective rendering

K. Cater, A. Chalmers, G. Ward

June 2003 **Proceedings of the 14th Eurographics workshop on Rendering**

Full text available:  pdf(4.78 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The perceived quality of computer graphics imagery depends on the accuracy of the rendered frames, as well as the capabilities of the human visual system. Fully detailed, high fidelity frames still take many minutes even hours to render on today's computers. The human eye is physically incapable of capturing a moving scene in full detail. We sense image detail only in a 2° foveal region, relying on rapid eye movements, or saccades, to jump between points of interest. Our brain then reassembles ...

18 Impostors & volumes: A lighting model for general participating media

Kyle Hegeman, Michael Ashikhmin, Simon Premože

April 2005 **Proceedings of the 2005 symposium on Interactive 3D graphics and games**

Full text available:  pdf(456.96 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Efficient and visually compelling reproduction of effects due to multiple scattering in


participating media remains one of the most difficult tasks in computer graphics. Although several fast techniques were recently developed, most of them work only for special types of media (for example, uniform or sufficiently dense) or require extensive precomputation. In this paper we present a lighting model for the general case of inhomogeneous medium and demonstrate its implementation on programmable gr ...

**Keywords:** graphics hardware, illumination, participating media, path integration, scattering

**19** Homomorphic factorization of BRDF-based lighting computation

Lutz Latta, Andreas Kolb

July 2002 **ACM Transactions on Graphics (TOG)**, Proceedings of the 29th annual conference on Computer graphics and interactive techniques, Volume 21 Issue 3

Full text available:  [pdf\(2.81 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Several techniques have been developed to approximate Bidirectional Reflectance Distribution Functions (BRDF) with acceptable quality and performance for realtime applications. The recently published *Homomorphic Factorization* by McCool et al. is a general approximation approach that can be used with various setups and for different quality requirements. In this paper we propose a new technique based on the Homomorphic Factorization. Instead of approximating the BRDF, our technique factoriz ...


**Keywords:** illumination, reflectance & shading model, rendering, rendering hardware, texture mapping

**20** Lightfield acquisition & display: 3D TV: a scalable system for real-time acquisition, transmission, and autostereoscopic display of dynamic scenes

Wojciech Matusik, Hanspeter Pfister

August 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 3

Full text available:  [pdf\(788.24 KB\)](#)

 [mov\(21:13 MIN\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Three-dimensional TV is expected to be the next revolution in the history of television. We implemented a 3D TV prototype system with real-time acquisition, transmission, and 3D display of dynamic scenes. We developed a distributed, scalable architecture to manage the high computation and bandwidth demands. Our system consists of an array of cameras, clusters of network-connected PCs, and a multi-projector 3D display. Multiple video streams are individually encoded and sent over a broadband network ...

**Keywords:** Autostereoscopic displays, camera arrays, image-based rendering, lightfields, multiview displays, projector arrays

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